DOCUMENT RESUME

ED 439 596 EF 005 687

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TITLE Planning for Flexibility, Not Obsolescence.
PUB DATE 1999-09-00
NOTE 11p.; Material first presented as a keynote address at the Urban Educational Facilities-21 Conference at the New Jersey Institute of Technology (September, 1999).
AVAILABLE FROM For full text: http://www.designshare.com/Research/EEK/Ehrenkrantz1.htm.
PUB TYPE Opinion Papers (120) -- Speeches/Meeting Papers (150)
EDRS PRICE MF01/PC01 Plus Postage.
DESCRIPTORS *Building Obsolescence; *Classroom Design; *Educational Facilities Design; Elementary Secondary Education; *Flexible Facilities; *Multipurpose Classrooms; Public Schools; *Space Utilization
IDENTIFIERS *Computer Integrated Instruction; Technology Integration

ABSTRACT

This speech discusses computer lab/classrooms and the issue of properly combining space, pedagogy, and technology when facility planning to better enhance student learning and support the teaching process. Several case studies illustrate classroom computer workstation configurations and how these may help or impede student learning and instructional methodology. Also addressed are the rapidly changing tools of education and the ways for achieving the flexibility today's schools will need to adequately embrace these changes. Enough space must be allocated to allow for a variety of learning environments to be adopted, both large and small, that fit with the curriculum and teaching needs, and be appropriate to the requirements of the students. Without enough space in the school design to help schools be flexible enough to accommodate changes in learning and teaching over time, the useful life of new schools will be shorter than their predecessors of 20 years earlier. (GR)

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Planning for Flexibility, Not Obsolescence

Ezra Ehrenkrantz
1999

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Planning for Flexibility, Not Obsolescence

By Ezra Ehrenkrantz, Ehrenkrantz Eckstut & Kuhn Architects

Ezra Ehrenkrantz is an American Institute of Architects Medal of Honor Award Winner, and a pioneer in the development of building systems that can readily adapt to organizational and technological change. The material in this article was first presented as the keynote address at the UEF-21 Conference at the New Jersey Institute of Technology in September, 1999. Urban Educational Facilities for the 21st Century (UEF-21) is a chapter of the Council of Educational Facility Planners International.

I began practicing architecture forty years ago and one observation that I have is that over these past forty years, in architecture, it seems that we have to learn things over and over again. We learn things once but then somehow they slip away and then we come into a new era where the lessons need to be learned all over again.

When I started working on school buildings some forty years ago, we were still feeling the impacts of World War II. Like today, there was a tremendous population explosion and people were looking to provide schools within limited budgets. They wanted these schools to be better than the schools that were constructed in the 1950's that were often on the borderline of being substandard. For example, in the typical 1950's school the space allocated to the classrooms, the floor-to-ceiling heights, the type of building services provided, there were no provisions for air-conditioning, for example, were all reduced to a minimum and the educational environment suffered.

By the time I began to practice in 1959 and started to work in schools in 1960, pressure was building to provide more appropriate schools. The typical schools, where classrooms were strung along double loaded corridors, were failing the students and people had become concerned with today's equivalent of the core curriculum. The focus had moved toward providing "individualized learning" and people desired to break down the "box" to enable students to learn to their capability and ability.

There were a variety of leading educators, J. Lloyd Trump, James McConnell and Howard Gores who in conjunction with the architects, Caudill Rowlett Scott and John Lyon Reed, began to be concerned with providing schools that could relate to the needs of individual students. Individualized scheduling was talked about, but without today's computers it was difficult to achieve. So while individualized scheduling was talked about, it was not realized anymore than, in certain way, we are realizing the completely integrated use of information technology within a classroom today. Teachers were not fully capable of optimally utilizing the tools to available to them as in the present time.

There were also discussions of larger goals which were not being met at that time. The proposed framework for meeting these goals was Team Teaching. Instead of having thirty students working lock-step in a classroom, the proposal was to provide a mix of small group instruction, regular class size instruction, and larger lecture groups.

"... one of the things that school boards and architects didn't recognize was that for teachers to work as a team, they needed time to plan together."

This would provide teachers with the time to work with small groups, and to orchestrate a certain amount of individualized, or really small group activities. Very quickly, school boards across the country began to opt for the construction of schools that would support a team teaching program focused on small group or "individualized instruction." However, one of the things that school boards and architects didn't recognize was that for teachers to work as a team, they needed time to plan together.

Many of the new facilities had open classrooms. For example, where there had been four separate classrooms each housing up to 30 students there were now one hundred and twenty kids in a large space, roughly sixty by sixty feet. In working with this larger group, the four teachers were supposed to break down the class and orchestrate the educational program. Unfortunately, in many cases they had to do this without being given the time to coordinate and plan to work together.

The lack of proper support for the new modes of teaching resulted in failures throughout the country. These failures created a schism between educators and architects. Architects liked the big open spaces, and educators

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went along because the conventional wisdom of the time suggested that this was the appropriate strategy. But because they didn't understand the costs and that this mode of teaching required extra staff to provide the time for each of the teachers to plan, the programs really broke down.

However, there were a few places around the country where the open classroom was made to work. There were people who understood it in these places and since these few examples of success indicated that it could be made to work, they just kept the broader application of the program going that much longer. In the end, the open classroom was clearly an example where a design solution was being put into place without an agreed upon funding base.

Over time, the open classroom schools have been removed and remodeled, and the concept of team teaching and the open classroom went into decline in many parts of the country because the criteria that would make it work were not recognized.

Today we are confronted with a whole new set of requirements through which society wants to provide for an appropriate education. We are emphasizing getting back to basics in terms of core curriculum and standards because there is dissatisfaction with the output of our educational system.

As well, we are currently working at a point in time where it is extremely difficult to get funds to meet today's educational requirements. These requirements take into account not only the more conventional types of education, but we are also looking to integrate information technology. Taking full advantage of information technology calls for new kinds of curriculum and these have new costs associated with them with regard to the technology itself and the necessary support.

There are also major changes taking place within our society. E-Commerce, for example, is emerging. It's currently comprising one percent of retail sales which effects local sales tax revenues. As E-Commerce expands it will mean that local sales taxes will be disappearing from communities.

"Because it was expensive to remodel classrooms, information technology was introduced into many schools by being concentrated in computer labs. The computer labs acted as old-style typewriter rooms and the work done with the computers was not integrated into the learning process ..."

In the New York metropolitan area, for example, we are already finding that some districts are already in great financial difficulty. These districts are having difficulty obtaining funds to maintain their current levels of expenditures. Meanwhile, the retail industry, in order to respond to E-Commerce, is developing Super Regional Recreation/Retail Centers that draw, not from the local community, but from a larger regional area.

So, instead of having a number of school districts, let's say twelve for example, that each have their own local shopping center, now there is only one Super Regional Center that is serving all of the people living within these twelve districts and beyond.

The tax revenues from this Super Regional Center are only going to one school district in the twelve, however. Each year more and more businesses and revenues are being lost to E-Commerce and the Super Regional Centers and this creates greater challenges for all districts and fewer and fewer school districts are doing well. We will soon have to look at the establishment of budgetary patterns for school districts that are going into decline.

As noted before, we are facing a situation where there is an increase in the population of school-age children. At the same time, two parent households are now working twenty percent more hours than they did twenty years ago just trying to stay in place.

With less time, the activities that parents did to prepare their children for education are becoming harder to do for the parent, so they depend more on the school. However, these new demands are arising in a context where the budget framework for the schools is being undermined by forces that go outside the educational field in terms of the provision of revenues.

Within this kind of framework, the ability to provide schools that are going to meet, not only today's requirements, but future requirements as well, becomes much more difficult to achieve. So, we have a situation analogous to that created by the federal highway programs in the 1960's when bypasses were put around the cities. Wherever the ring road cut a radial, we had a place for a new shopping center, a new office park, and new suburban housing, drawing considerable revenue out of the inner cities to those addresses that were created by the bypasses.

Now we have a situation where instead of a "hard bypasses," we have "virtual bypasses" being created that will take revenues from communities. In this situation, the communities that will lose are not limited to a few major cities as in the 1960's. We're now talking about the suburbs and the major cities.

Everyone is affected by E-Commerce simultaneously. It's a universal bypass system that is making things more difficult for school administrators and designers. We have to take a look at the way we utilize the resources that we have and target what is specifically needed for our educational program.

As we look at the changes that had taken place in education in the 1970's and 1980's, there was a disconnect, as mentioned before, where leading educators no longer trusted architects. Seizer, Slaven, Smith and other educational leaders were really not concerned with space.

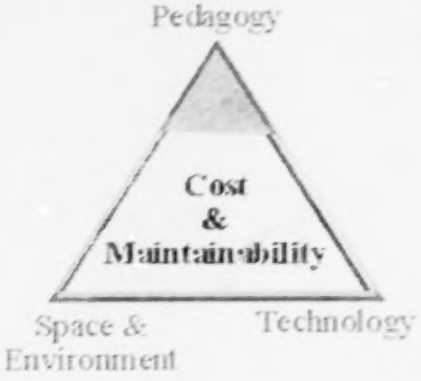
As the Coalition of Essential Schools began to get going and get school districts to join the program, Seizer essentially said, that it doesn't matter what the architecture is. This notion emerged from a lack of trust based on the belief that in the previous era, the design professions were pushing for forms of education that required levels of resource allocation that was not being made available by local school boards.

With this disconnect, the educational leaders went through a long period of time without considering the role of the physical environment. Now, information technology has brought them back. They found that they needed to redefine what went into the schools in order to facilitate the use of information technology. These new tools required the involvement of the design professional again.

A variety of approaches were developed to try and use information technology with its attendant requirements for space, power, HVAC, etc. In the process of doing that work, the professions again reunited. But they reunited to address a specific set of requirements at a given point in time.

Because it was expensive to remodel classrooms, information technology was introduced into many schools by being concentrated in computer labs. The computer labs acted as old-style typewriter rooms and the work done with the computers was not integrated into the learning process taking place outside of the labs. After a few years, students, and their parents, gained some currency with information technology.

In response to the lack of integration of the information technology into the learning process, technology migrated from the computer lab to the classrooms. One, two, maybe up to six computers were put into a classroom. However, the teachers had absolutely no idea about how to incorporate two computers within a classroom curriculum or how to utilize them in an effective way on a variety of educational modules.



But the number of computers provided was predetermined by the number of computers that were already owned and by the power capacity that would permit only one or two computers to be put in a classroom in lieu of different audiovisual aids or other kinds of tools. While this approach helped to minimize the cost, it didn't work either. Over time, the number of computers in the classroom has increased and each increase has resulted in different designs being developed.

However, what has not happened in this process is to take a look generally at what the basic task is in terms of learning. As Figure 1 indicates: there is a pedagogical system, space and appropriate environment and the technology and tools that will be used. Those three elements working together as a triad provide a system or a framework to underlie the learning process.

And if those three elements work together in an effective way, you then have the ability to create the curriculum, the basic program of instruction, to facilitate a learning process. Now, if the limitation on what can be achieved is based on technology and not the learning system -- that is, if the limitation is how many computers are going to work off the school's existing power system -- the ability to optimize the whole system is going to be limited.

With these limitations, the results are going to be poor. Little by little, some more money has been found and we've begun to go in and remodel but the costs are extremely high.

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As mentioned before, initially there was the computer lab; everybody has seen them. Computer labs alone within a school serve no useful purpose. As technology migrated into the classrooms, often four computers were put in a classroom and the original power system couldn't support them. Besides, spatially, the classrooms won't support putting in more than four, five or six desktop computers at a maximum because the computers take up desks permanently.

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If you were going to put in twelve computers in a typical classroom, with one computer for every two kids, there wouldn't be any desks left for the students. So there is a space limitation with hardwired computers in terms of how many you can put into a classroom. Accordingly, innovations were made.

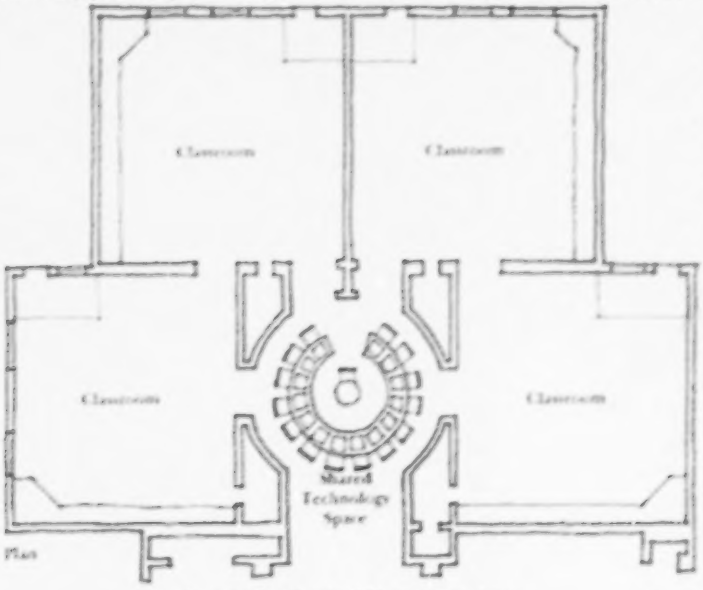

Figure 2 - Central Computer Area

Figure 2 shows an example from an elementary school. This example was identified in the studies performed at our research center at the New Jersey Institute of Technology. Susan Steubing was the director of that study. In this school, they took all of the computers from four classrooms and concentrated them into a central space. This provided enough computers that an entire class could work together with the technology with two students sharing a station. This sharing provided one way of working.

What isn't recognized is that in this marvelous design the teachers are team teaching. They have to plan to co-use a limited resource and the ability to do cooperative learning with small teams of students working together isn't facilitated by this configuration. At a given point in time, this was the ideal solution that teachers, administration, everyone from that school district wanted.

But it only had a potential life of maybe two and a half years of applicability and it served the needs very well for that two and a half-year period of time. But it is not going to serve the school's needs in the future.

Figure 3 shows an example from a high school that has computers around the perimeter and all of the students are sitting in the middle so you have the conventional lecture approach for education. The students have the option to work individually at their own computer workstation or as a class in a lecture format.

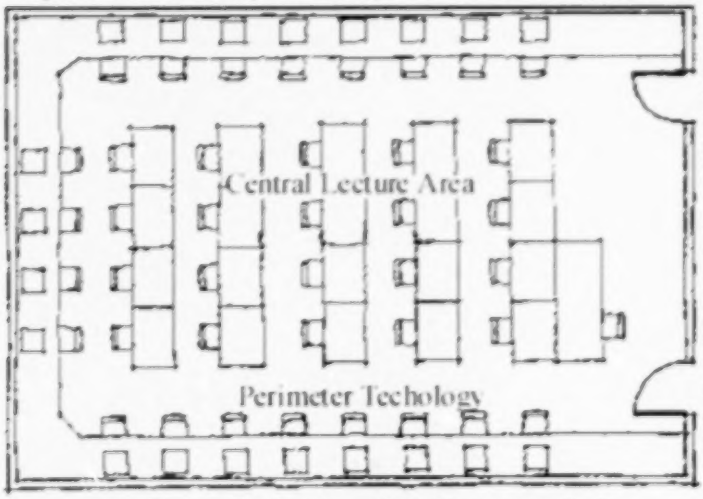

Figure 3 - Lecture Style Computer Lab

When we take a look at the modes of learning, from the teacher being the source of information, to the teacher being the coach, the student learning from their peers in a cooperative educational program, to student learning individually using educational television and other sources of information, it becomes evident that there are many ways by which you can learn.

This model is one that called out a very specific way by which the teachers, students and tools could work together. Again, it's very limited in the number of ways by which it could work, because the computers are all hardwired around the classroom.

Figure 4 is an example, also one Susan Stuebing's marvelous case study schools, based on the cooperative learning process from Port Hueneme, California. There are clusters where six students work together as a team. All of the students can see through to the teacher's station as well as being able to work as teams of six. And so you have a classroom that is broken up into five clusters of six students which is a marvelous solution to a

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problem stated.

In the future will all education materials for cooperative learning be created for groups of six? Is that the only way that you're going to try and work with students in terms of providing information that's going to be appropriate? Again, with limited resources, a lot of money has been spent because the technology is expensive. When arrayed in this way you have limited solutions that are not going to bear the passage of time. Wireless technology has recently become viable. In each of these examples, however, everything is being fixed. Technology is changing on an eighteen-month cycle. Yet, we are building in fixed solutions. Whether it's the 1960's open classrooms, or in this kind of cooperative learning environment, we are dealing with specific designs that do not relate to the nature and rate of change which is taking place.

That becomes, I believe, one of the most important, guiding principles that we have for facilities today. We have to take a look at all of the different ways by which students learn. We have to take a look at the dynamics for cooperative learning where for example, you can work with groups of four students for certain types of problems and for others you can work with a group of twelve. In working in these ways you have to have flexibility.

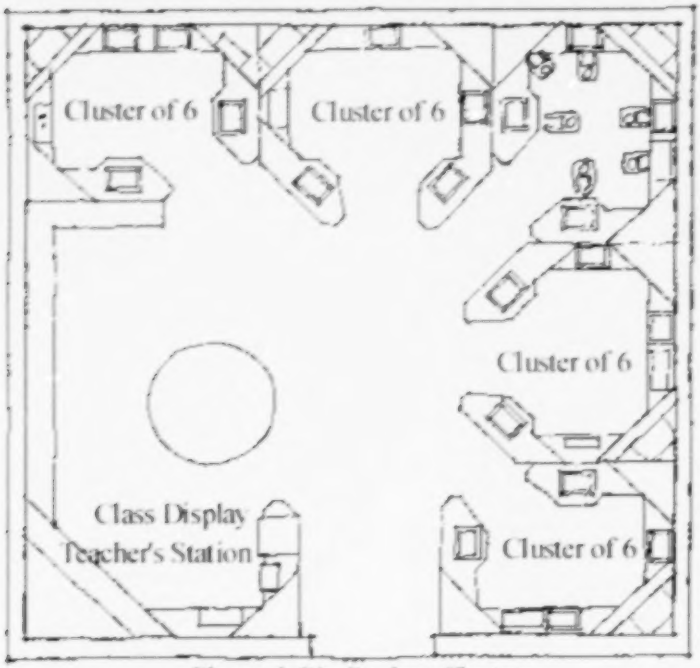

Figure 4. Six-Student Clusters

The technological tools are there. We've known for years that we are moving towards these types of technological tools being available, but at the same time we have been hardwiring our solutions.

The Port Hueneme school was one of the first schools to solve the problem of having to look over the computer to see the teacher. The computers were recessed into the counters. Again, there was ingenuity involved in these solutions but they were not necessarily relating to an ever more difficult financial situation to get schools funded.

To build a school that might have a useful lifetime of forty years, and then pick configurations that have a two and a half-year optimal lifetime, does not make sense.

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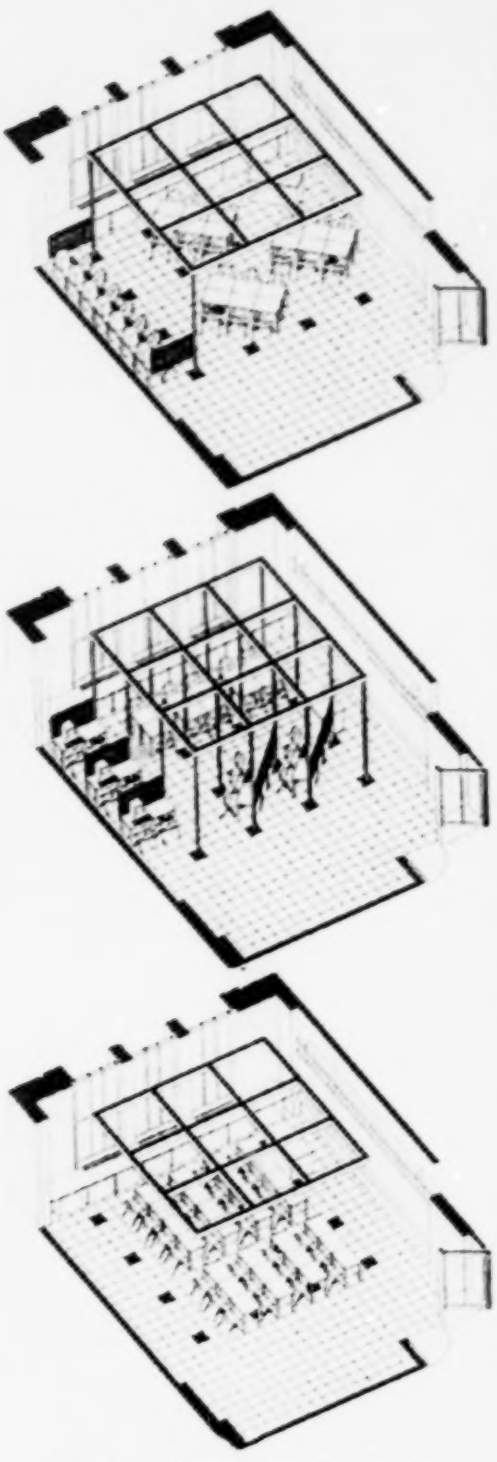

Figure 5 - Elementary Classroom

Figure 5 shows some diagrams of an elementary school classroom that we recently designed for the New York City School Construction Authority. In each classroom there is a trellis that has the ability to conceal ceiling wiring and power and data poles can be dropped from any point.

Around the perimeter, all of the tack rails are surface mounted raceways. So even though the school was designed at a point in time when the program only called for one computer in each classroom with the potential of adding one more, everything is put in place for both island and perimeter utilization of technology when greater levels of technology became available.

In keeping with the philosophy that I am espousing, the design provided for the ability to put in a computer for every student, even if you had to hardwire it. The routes for power and data were all established in advance.

In the meantime, the trellis provides a means of hanging student work and other displays, so that the ceiling becomes another educational work surface.

Bringing services to classrooms is very much like choreographing dance. As different learning approaches develop, the framework of the classroom and school should support these changes, with minimal expenditure, as a good theater would support different choreography over time.

This kind of an approach, I believe, is more and more important since it is very difficult to predict how technology is going to change and to identify what funding might be available. We have not yet reached the point where the school districts have gone back to the computer manufacturers and said, "We want laptops. But don't give us what you make for businessmen to carry through airports and travel miles. We want to go from a recharging station a maximum of thirty feet. We assume that we'll recharge them in the evening off of the lighting system when it's not in use. And we want other kinds of attributes. And by the way, we are interested in buying five million of these a year. Would you make one? Oh, and it has to sell for under five hundred dollars."

The leverage that the educational disciplines have with respect to getting tools that would facilitate what they are looking for is very large. These tools could provide the ability to work in ways that makes sense for each subject area and activity. Groups could range from a cooperative team of six for one activity, or in another area a large group of half the class could work as a team. In another case students could work totally individually and so on.

You have many permutations and if the furniture and fittings permit desks and other things to move, you can then relate the layout of the classroom to the subjects that are being learned. Now the key is that there is a need to look at what is it that is required in terms of curriculum.

I would like to go through a couple of stories in order to segueway into this subject, because I believe that

what we have seen in terms of change with technology only scratches the surface of the flexibility that is going to be needed to accommodate changes in curriculum.

The first story I'll like to tell has to do with the first high school that I designed. At that time, one of the spaces called for was the biology classroom and I initially thought that we would be designing a biology classroom for a mode of teaching that was the same as when I was taught biology. That was when biology was the study of death. Everything was pickled and you dissected. We started to design the school and met with a biology teacher, who told us "oh no, biology is the study of life. We have live animals in the classroom, we have live plants," and so on.

We went back to visit the school a couple of years after its opening and I found out that the teacher was very excited about what had happened there. There had been some live births of some of the animals in class time. It was very exciting. Word of that rippled through the entire school.

Today with Nova, in half an hour you can get the entire life cycle of any animal. If you watch the life cycle of an animal on Nova, however, do you fully understand what an animal is? The caring, the feeding, cleaning up after it and so on... There are things that you learned in real time that you can not learn in fast time.

When you begin to use real time experience to lay down a foundation, a core, and then when you see many other animals in fast time, you will be able to digest the information in this fast time manner because of the foundation, or core, knowledge.

From this story, one of the things that we have discovered is that the ability to have, in any given classroom, the opportunity to be able to mixe real time and fast time learning is essential. You shouldn't have specific places that are for the computer or specific places that are for lecture and so on. These different activities have to be related to one another. They need to become suffused into a classroom learning situation.

The next story I'll like to tell is one from when I served on a long span structures committee for the AIA after there had been some catastrophic structural failures about ten years ago. Leslie Robinson, who was the structural engineer for the World Trade Center, also served on this committee. In speculating why the failures were occurring at that point in time, he indicated that when he studied structural engineering, students would design five buildings in their entire university career. Each was designed with a slide rule. Each member was sized by hand.

Students who learned by this method developed an understanding of what that member size should be to handle certain kinds of loads. Today, he said, all the engineers that he employed had come out of colleges and universities where they had designed sixty buildings on the computer and they could tell you whether a steel, pre-cast concrete or a post-tensioned concrete building would be more economical.

But in school they had not designed the individual structural members; the computer designed the members. If the member size isn't right, there is no internal trigger that says this isn't what it should be.

From that discussion I picked up another message, which is that different learning media, facilitate learning in different areas. One of the things Leslie said that he wanted to do is to hire students that have done three buildings "long hand" and twenty on the computer. But, would you believe that there isn't a single university in the United States that teaches structural engineering like this?

To return to relating the different kinds of learning to different tools, we need a multiplicity of tools calibrated to provide optimal learning of the specific types of information. If we can't achieve this it is like asking why an elementary school student should learn multiplication and division when they could just use a calculator. This approach might work fine, as long as they don't plug in the wrong numbers. Students need to understand what to expect as a result.

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We are looking for a variety of tools. We are looking for tools that are going to be worked in real time and slow time, the way I learned. We are looking for tools that once you establish a proper base, are going to permit students to take advantage of that base and learn, in fast time, a hell of a lot more than I and those of my age were able to do in the same amount of time.

If these tools are going to be properly calibrated and sequenced, you're going to have a variety of things done in each subject area by module. For example, let's imagine that we have a social studies class, say American History where you typically studied the Civil War. We currently do it from documents that have been copied from documents, which have been copied from the last textbook, etc.

Imagine that the Smithsonian finds all of the papers from the Civil War period from New York, Boston, Richmond and Atlanta and a teacher could establish project teams of four students where each team has a student acting as a resident of those cities. (Port Hueneme would have add Philadelphia and Birmingham because it's set up in teams of six.) The students read from original sources what was recorded and they have to give a combined report of every fifth period or every sixth period.

NYC Classroom (Figure 5), Walter Dufrese for EE&K Architects, 1995

They might take turns in reporting so that part of their time is giving reports. The rest of their time is in debating and discussing the different ways that the different residents of those cities viewed the events of the war, working from original material.

That particular modular block of work is based again in forces of information that can be made available. I am sure that in my own mind that if we structured this subject this way, it would be a better way to study Civil War history, than the way that I studied it. Students would learn more and get a lot more out of it.

If each different subject area has its nuances that are accommodated, and so your tools are changing, the curriculum is changing and the educational modules that you use are changing, the rate of change of what is taking place within the classroom is moving very quickly.

If the use of computers or laptops becomes universal, what you've established is a mass market that has enough uniformity where the people who develop educational materials for that Port Hueneme school or for another specific school can again begin to develop educational materials for the entire country. That provides a liberating element that would make it possible to design and perfect and improve educational tools.

"Flexibility in schools happens in three different ways. One is the demountable partition ... This is not going to support the kind of flexibility for the changes that I am talking about."

If this ferment is going on, in terms of the curriculum materials, if we begin to reach a plateau in terms of the evolution that we been going through the last ten years, with regard to information technology so that there certain normative elements that people can relate to, this would be the beginning of a point in time where changes will come very quickly.

Flexibility in schools happens in three different ways. One, is the demountable partition where you move things around and major changes require major capital budgets. It is appropriate for the old way of education where changes are going to made maybe every twelve to twenty years and they are going to be implemented at one time throughout the school. This is not going to support the kind of flexibility for the changes that I am talking about.

The second way of achieving flexibility is to provide enough space within classrooms to permit multiple and different activities to occur. This is a strategy like in those large Victorian houses, where you had a lot of

flexibility because the rooms were big enough. One of the things that we find however, is as I mentioned in the beginning, we're in a period like the 1950's again. Everybody is trying to cut back and save money.

" ... we are hardwiring a single design to a single situation and ensuring that the building will obsolesce and not be worthy of providing a good learning environment over time."

Often this results in the provision of the minimum allocation of space possible to house the current program. In these instances, we are hardwiring a single design to a single situation and ensuring that the building will obsolesce and not be worthy of providing a good learning environment over time. We must have enough space to provide flexibility where in the teachers and the students control that flexibility.

We can go one step further. We may have more than just classrooms and spaces of a uniform size. We can have spaces of varying size that can house the range of larger group activities and smaller group activities. Then as different activities need to use a different process or there is a need for a different numbers of students to work together, you can begin to flip over the use of a couple of spaces. By switching activities around into different spaces over time, we can have the opportunity of relating to particular needs even more quickly and effectively without major construction.

However, we still have to be able to have multiple activities taking place within a single classroom. As we look towards the future, one of the key criteria for the design of any school building is that the building should become a laboratory for its own evolution.

If you begin to think in terms of the rate of change that way, and we have talked of choreography, we can begin to think of the educational space as a theater where the teacher and students, the director and the actors in our analogy, can determine how they use that space so that the play of learning that goes on is appropriate to the requirements of those students, the subject that they are studying and the tools that they are using.

This means that designing a proscenium stage type of theater isn't going to work anymore than a theater in the round. We have to be thinking of how to create the appropriate forms that are going to provide the level of flexibility that would permit us to design keeping in mind the concept of the school being a laboratory for its own evolution.

To achieve this we must have space and we must be able to service that space. And if we cut short on one of the those elements today, our schools are not going to be able to achieve the 20-year useful life that we have had with the 1950's schools. These schools are going to have a two and a half year useful life. And that two and a half year useful life is going to result in poor student performance by any measure. And all of the things that we talk about in terms of the assessment of education are not going to make sense and we will not be properly allocating the taxpayer's dollars.

Thank you.

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